QA1, QA2, QB3 — 48+2 / 70 — Statics → First

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Group : ☐ Mechatronics ☒ Electrical

**Statics Test 1** (*This test carries 25% of the overall mark*) -

Attempt **2** questions from section A and only **2** questions from section B

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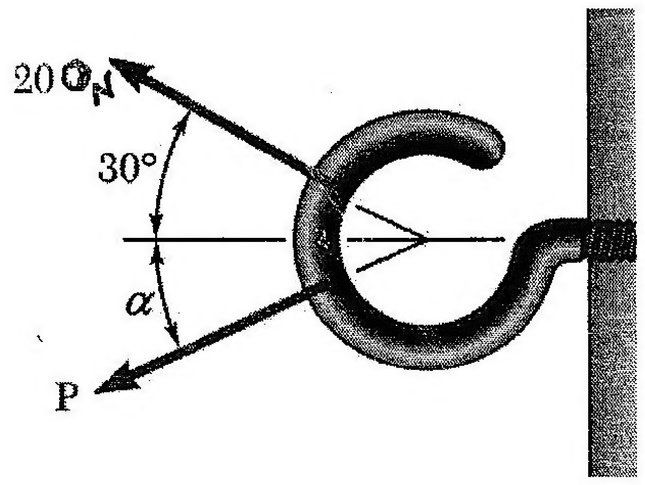
**Section A: Multiple Choice - You must show your working out** Date: 10.26.2010

QA1

Two forces are applied as shown to a hook support as shown. One of the forces is 200N and makes an angle of 30° with the horizontal while P makes an angle of α. Use trigonometry or otherwise, determine:




(*a*) The magnitude of the smallest force P for which the resultant R of the two forces applied to the support is horizontal, (*b*) the corresponding magnitude of R. Choose one of the following answers:

a) P=10 N, R = 17.32 N

b) P=100 N, R = 153.2 N

c) P=110 N, R = 173.2 N

d) P=100 N, R = 173.2 N ✓ (20 marks)

10/10

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**Solution**

(a) ∴ $\Sigma F_y = 0$ — Smallest force ⇒ $\alpha = 90^\circ$ ✓

$200 \sin 30 - P \sin\alpha = 0$

$200 \sin 30 = P \sin\alpha \Rightarrow \alpha = 90^\circ$

$100 = P \sin 90^\circ$

∴ $P = 100$ N ✓

10/10

(b) ∴ $R = \Sigma F_x = [redacted] \cdot 200 \cos 30 + 100 \cos 90^\circ$

$= 200\ (.860) + 0 = 173.2$ N

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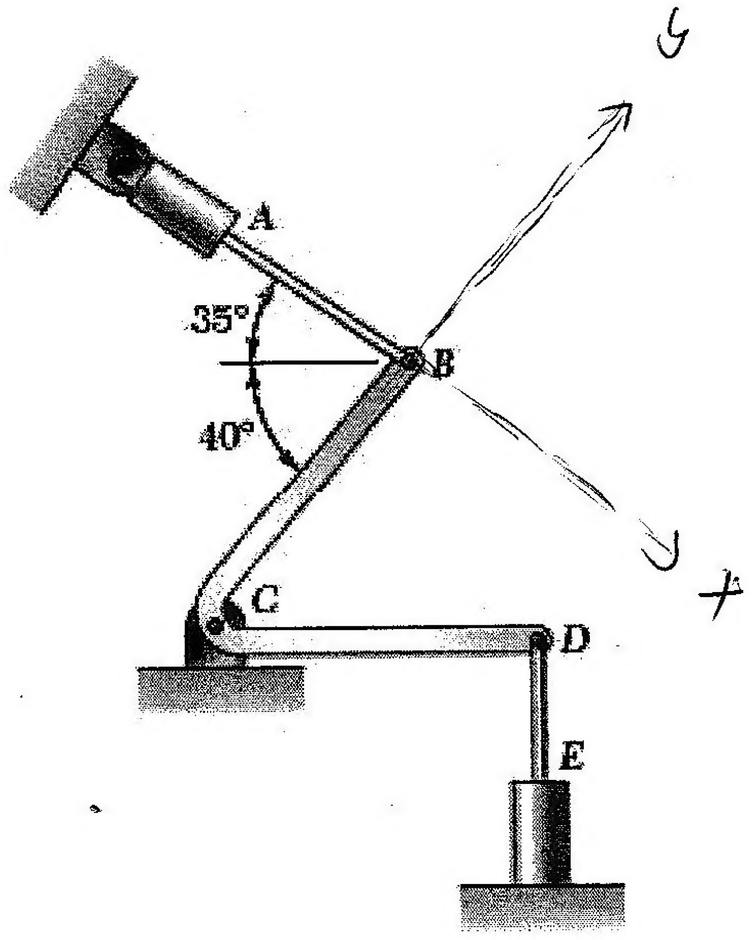
**QA2 (Section A)**

Activator rod *AB* exerts on crank *BCD* a force **P** directed along line *AB*. Draw the FBD for members AB and BCD. Also, knowing that **P** must have a 250 N component perpendicular to arm *BC* of the crank, determine:




a) The magnitude of the force **P**,

b) Its component ($P_{BC}$ ) along *BC [assume BC is straight]*.

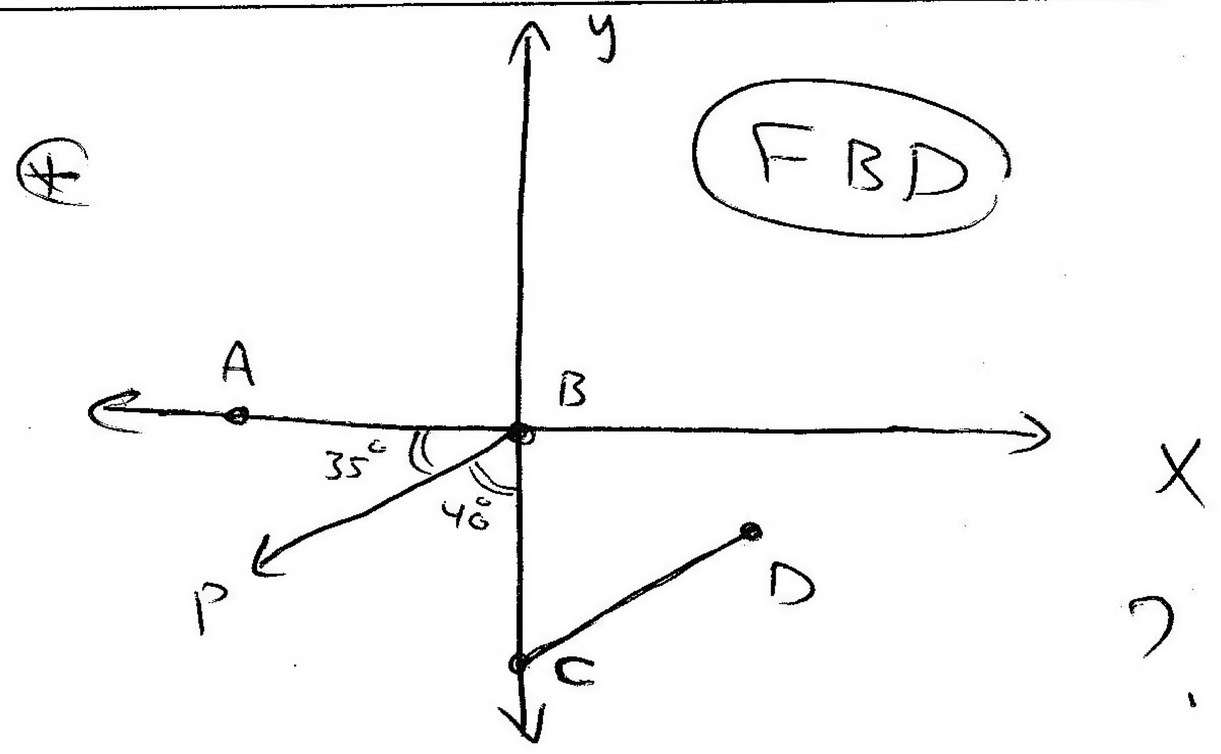
*Select one answer from the following answers:*

a) $P = 25.9$ N, $P_{BC} = 57$ N
b) $P = 259$ N, $P_{BC} = 67$ N
c) $P = 239$ N, $P_{BC} = 6.7$ N
d) $P = 259$ N, $P_{BC} = 670$ N

0/10

**(20 marks)**

**Solution**




FBD

0/20

Section B (You need to answer **ANY 2** questions only from this section)

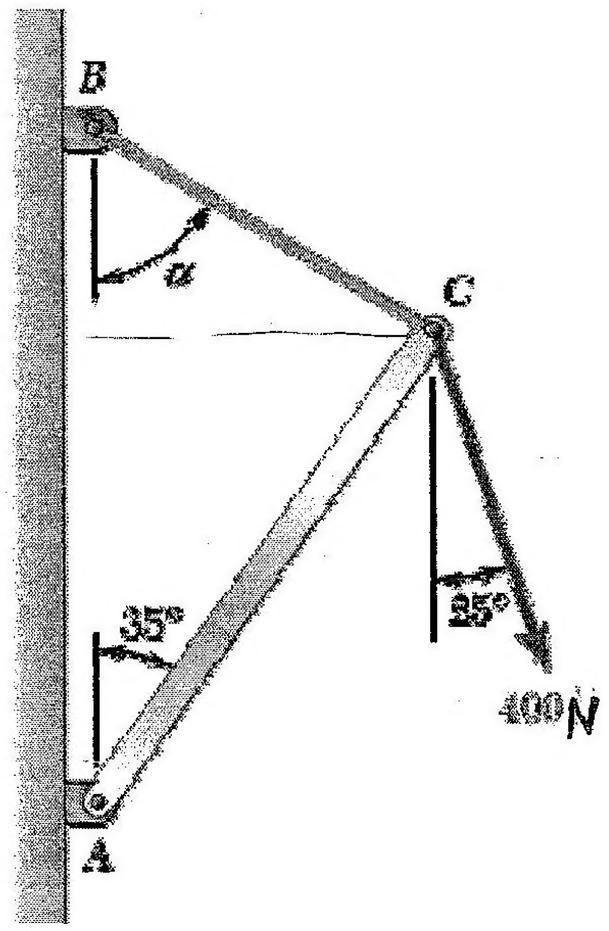
**QB1**

A uniform beam, AC, is held in the position, as shown in the diagram, by a cable BC which is inclined by an angle of $\alpha = 50°$ with the vertical. A force of 400 N is applied at point C, making an angle of 25° with the vertical. The pin at A exerts a force on AC directed a long line AC. For this system:

a) Sketch the Free Body Diagram of the beam AC showing ALL forces. **(5 marks)**

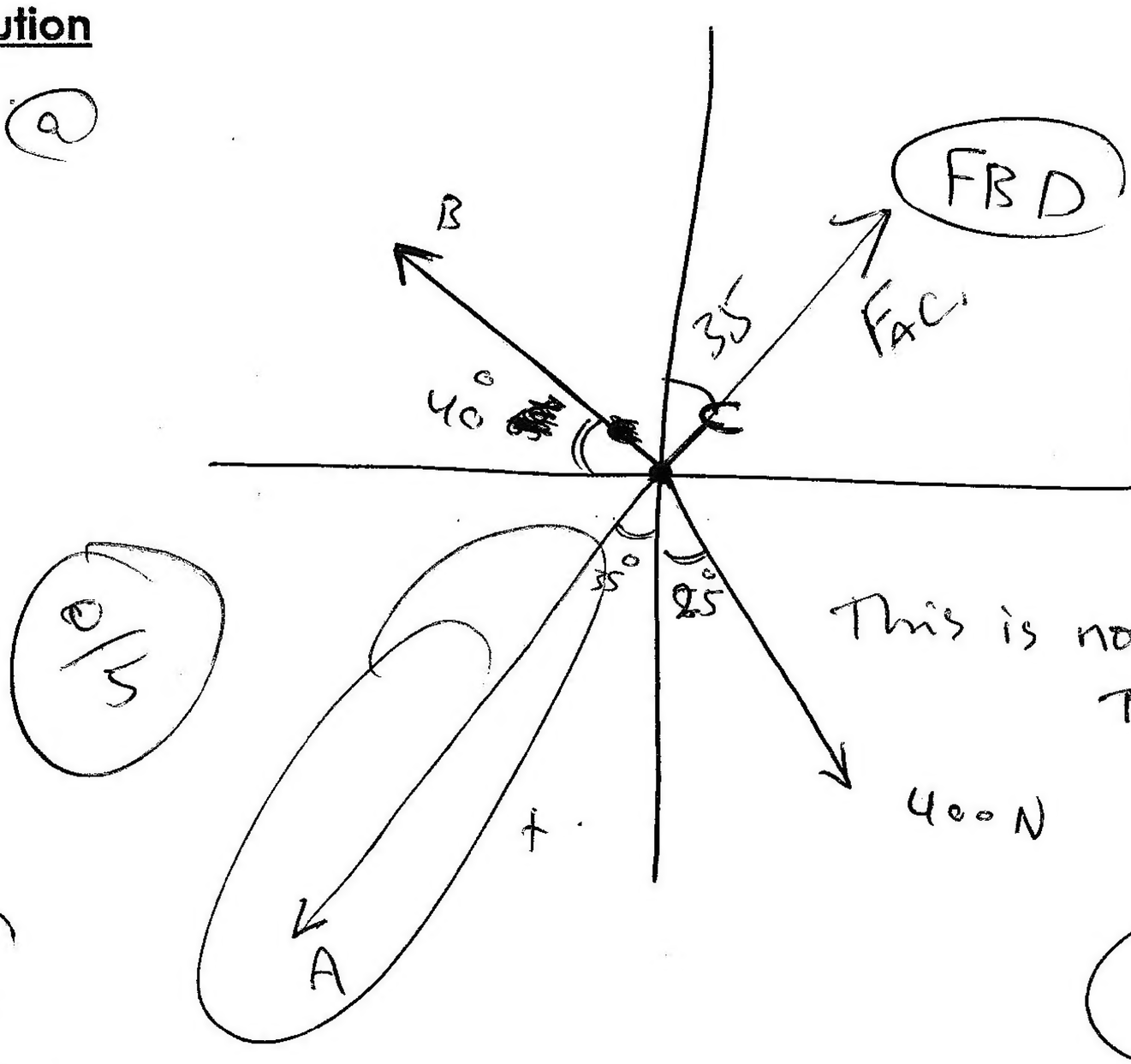
b) By using accurate drawing of forces (or otherwise), determine the magnitude of the force in AC **(15 marks)**

c) Find the tension in the cable BC **(10 marks)**




**Solution**

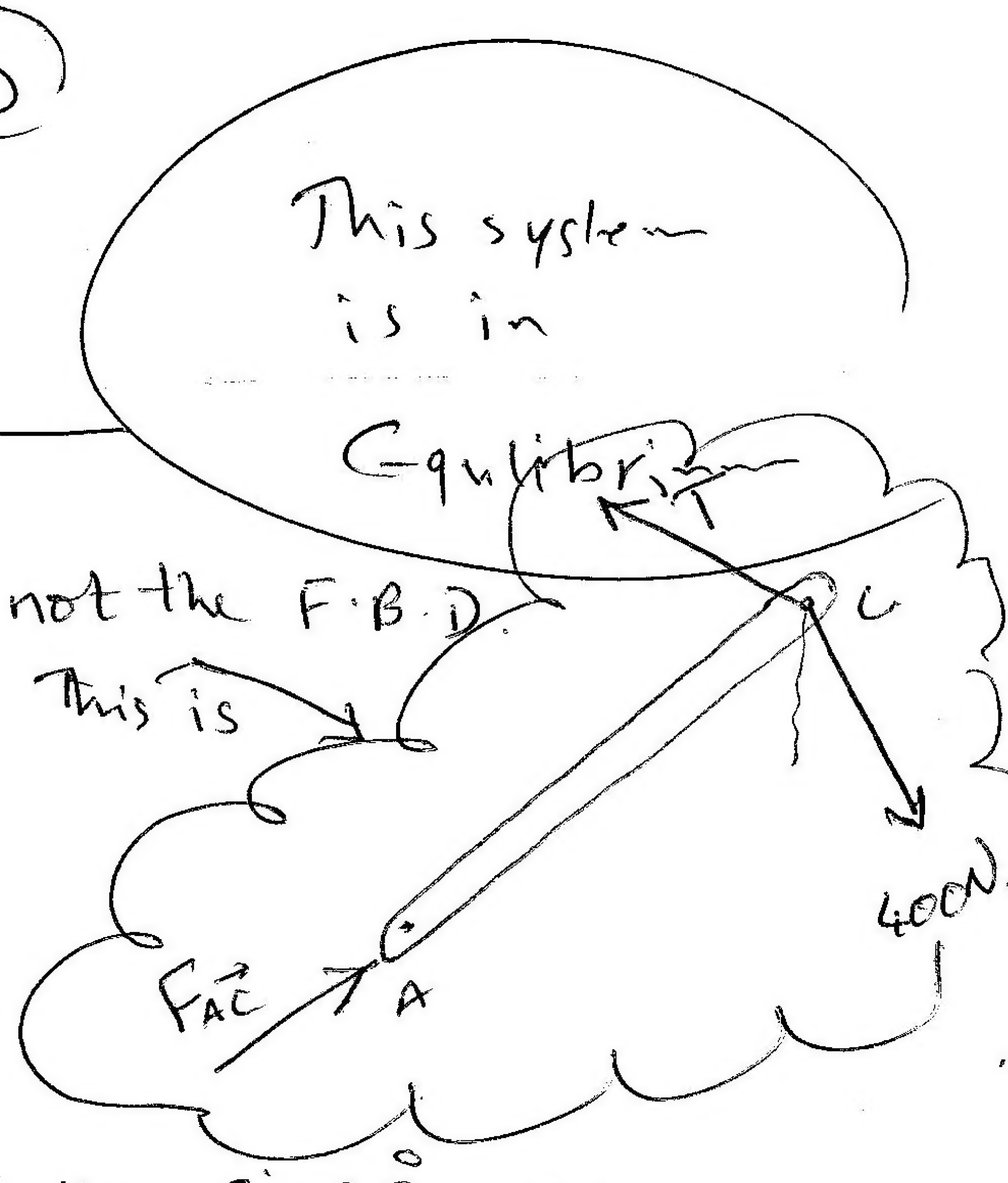
(a)




5/5

(b)

This system is in Equilibrium




This is not the F.B.D

This is

$$\Sigma F_x \quad -BC\cos 40 - AC\sin 35^\circ + 400\sin 25^\circ = 0$$

$$-0.77\,BC - 0.57\,AC + 169 = 0 \quad \text{——— (1)}$$

$$\Sigma F_y \quad BC\sin 40^\circ - AC\cos 35^\circ - 400\cos 25^\circ = 0$$

$$0.64\,BC - 0.82\,AC - 362.5 = 0$$

$$0.64\,BC - 0.82\,AC = 362.5 \quad \text{——— (2)}$$

But $BC = \dfrac{362.5 + 0.82\,AC}{0.64}$

$$BC = 566.4 + 1.28\,AC$$

$\therefore \quad -0.77(566.4 + 1.28\,AC) - 0.57\,AC + 169 = 0$

$-436.1 - 0.98\,AC - 0.57\,AC + 169 = 0$

$-1.55\,AC - 267.1 = 0$

$1.55\,AC = -267.1 \Rightarrow AC = \frac{-267.1}{1.55}$

$= \boxed{172.3\ N}$ ✓

But $\overline{FAC}$ is not in the -ve direction. ✗

(c) $BC = 566.4 + 1.28\,(-172.3)$

$= 566.4 + (-220.5)$

$= \boxed{345.9\ N}$ ✓

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Your workout could be right if you have chosen the correct direction for BC.

22/25

**QB2**

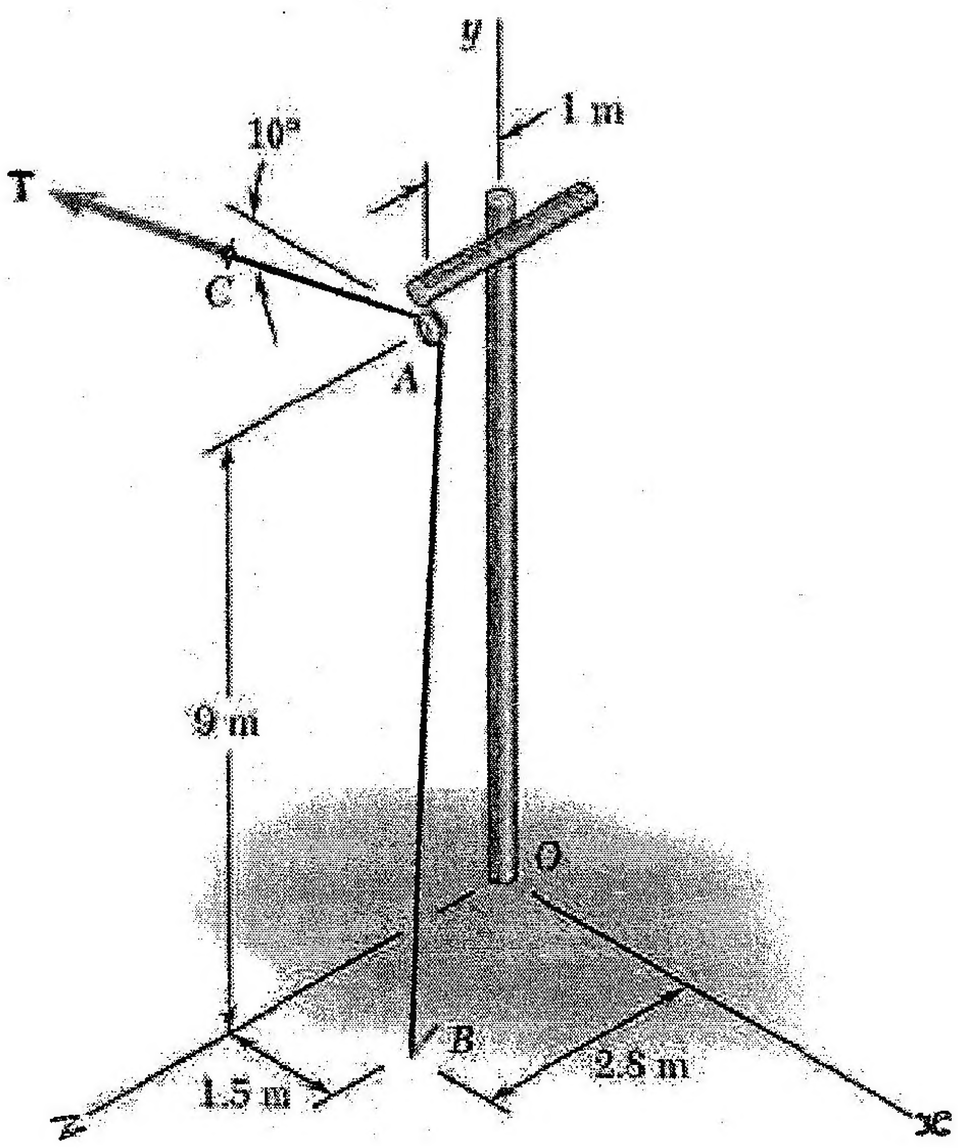
Before a telephone cable is strung, rope BAC is tied to the stake at B and is passed over a pulley at A as shown in the diagram. If part AC of the rope lies in the plane parallel to the xy-plane and that the tension (T) in the rope is 130 N, find the following:

a) The resultant force exerted on the pulley by the rope ends - in terms of the i, j & k

**(15 marks)**

b) The moment of this resultant about an axis through point O (again in terms of i, j, k).

**(15 marks)**

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**Solution**

**QB3**

A winch tower, OB, is held vertically upwards by a system of 3 cables. The tower is supported at point (O) by a universal pin-joint while its top end (B) is held in position by the cables. The tension in cable BA is 3200 N.

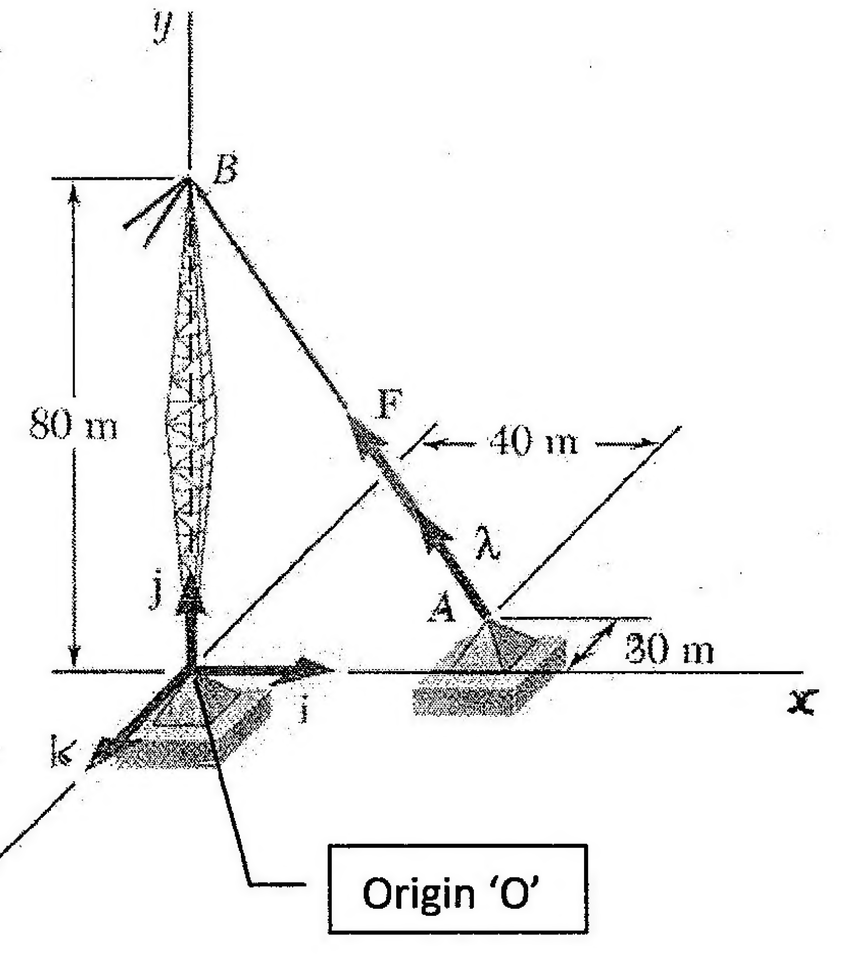
Determine:

a) The components $F_x$, $F_y$, $F_z$ of the force acting on the bolt at *A (in terms of i, j and k)*

**(15 marks)**

b) The moment of the force (F) about the origin 'O' (in terms of i, j and k)

**(15 marks)**




(a) $F = 3200\ N$

$\vec{F} = \vec{\lambda} F$

$\vec{\lambda} = \dfrac{r_{B/A}}{|r_{B/A}|}$

$r_{B/A} = r_B - r_A = 80\hat{j} - (40\hat{i} - 30\hat{k})$ ✓

$= \boxed{-40\hat{i} + 80\hat{j} + 30\hat{k}}$ m

$|r_{B/A}| = \sqrt{(-40)^2 + (80)^2 + (30)^2} = \sqrt{1600 + 6400 + 900} = \boxed{94.3\ m}$

$\therefore \vec{\lambda} = \dfrac{-40\hat{i} + 80\hat{j} + 30\hat{k}}{94.3} = \boxed{-0.42\hat{i} + 0.85\hat{j} + 0.32\hat{k}}$

$\therefore \vec{F} = 3200(-0.420 + 0.85\hat{j} + 0.32\hat{k})$

$= \boxed{-1344\hat{i} + 2720\hat{j} + 1024\hat{k}}$ N

1357 2713 1017.6

(b) $M_o = \vec{r} \times \vec{F}$

$\vec{r}_A = (40\hat{i} - 30\hat{k})$

$\therefore M_o = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 40 & 0 & -30 \\ -1344 & 2720 & 1024 \end{vmatrix}$

خلف الصفحة

$$= \hat{i}(81600) - \hat{j}(40960 - (40320)) + \hat{k}(108800)$$

$$= \boxed{81600\hat{i} - 640\hat{j} + 108800\hat{k}} \text{ N.m}$$

81408 ← 81600 | 0 ← 640 | 108544 ← 108800

if you were more accurate, you would have got the above results

13+2/15